A Quantitative Ecological Assessment of Diving Sites in the Egyptian Red Sea During a Period of Severe Anchor Damage: A Baseline for Restoration and Sustainable Tourism Management

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This paper assesses damage to diving sites off Hurghada and Safaga, Egypt, and examines management responses and options. Data were obtained using the line-intercept-transect method. Using general field observations, a control site comparison and a historical comparison, it was found that the four diving sites studied suffered varying degrees of physical damage and needed management attention. Some transect locations had experienced severe physical damage while others had escaped damage. The most obvious difference between the control site and the four damaged sites (at both 4 and 8 m depths) was the consistently high percentage cover of hard coral (especially *Acropora* coral) and low percentage cover of soft corals among all transects at the Giftun Canal control site. Total algae percentages were also consistently higher at impacted transect sites versus the control site. From a historical perspective, at the Small Giftun site from 1987 to 1996, percentage hard coral cover decreased by 43% and algal cover increased over fourfold. If the diving tourism industry is to sustain itself in the Egyptian Red Sea, every management effort must be made to minimise controllable sources of stress on the coral reef system. Dive site management programme options, based on peer-reviewed carrying capacity research and stakeholder involvement, are reviewed.

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Introduction

Resort development along the Red Sea coast of Egypt is proceeding rapidly. Over 50 new tourism centres are planned along the western coast of the Red Sea – creating a new Red Sea Riviera. This development and associated diving activities are threatening valuable coral reef ecosystems (Jameson 1998; Jameson *et al.*, 1995). The clear warm waters of the Red Sea coasts, with their extensive coral reefs, make them especially attractive for diving.

Until about 1997, on the 1000 km western coast of the Red Sea (Figure 1), tourism development proceeded without an active integrated coastal management system in place. The reefs, particularly in the Hurghada sector, were placed under considerable stress as a result (Jameson & Smith, 1997).

The installation of mooring buoys, the management of the number of diving vessels using mooring buoys with respect to time and location and limits on the number of dives per year are all effective tools in reducing physical damage to coral reefs. For many years before the designation of a Marine Protected Area, legally known as the Elba Protectorate[1], and until about 1997, management of diving and anchoring within the Elba Protectorate was non-existent. As a result, the large number of diving vessels, estimated in late 1996 at about 60–100 full-time operators (with seasonal variation) and centres (about 80) operating in the Hurghada area had free rein to operate in the Protectorate unsupervised. This caused considerable physical damage to coral reefs, through indiscriminate anchoring on coral reefs and by overdiving (exceeding the carrying capacity) of dive sites (Jameson *et al.*, 1999).

In early 1997, the Hurghada Environmental Protection and Conservation Association (HEPCA) with financial assistance from the United States Agency for International Development (USAID) installed over 250 mooring buoys (including reef top pins) at popular local diving sites within the Elba Protectorate. HEPCA is also responsible for maintaining these buoys/pins. Mooring buoys remove the need for dive boats to drop anchor. This programme has expanded in geographical scope over the years (over 1000 mooring buoys installed) and is now also supported by the Egyptian Environmental Affairs Authority (EEAA). Damaging coral reef resources is prohibited in the Elba Protectorate and in mid-1997 EEAA rangers were assigned to Hurghada to enforce Laws 4 and 102 and to ensure that vessels are using the buoys/pins and not anchoring on coral reefs.

Information for accurately evaluating the condition of Red Sea diving sites is critical for effective management and sustainable tourism. To be useful, monitoring programmes must be designed with scientific and management questions in mind and their development and implementation must involve managers and user groups to the maximum extent possible. A particular need is the ability to quickly and accurately assess the condition of ecosystems and the level of environmental threats (Eakin *et al.*, 1997).

This assessment provides quantitative baseline data for monitoring and assessing the effectiveness of the HEPCA mooring buoy programme and Egyptian government coral reef restoration and conservation efforts. It offers a case study in sustainable dive tourism management.

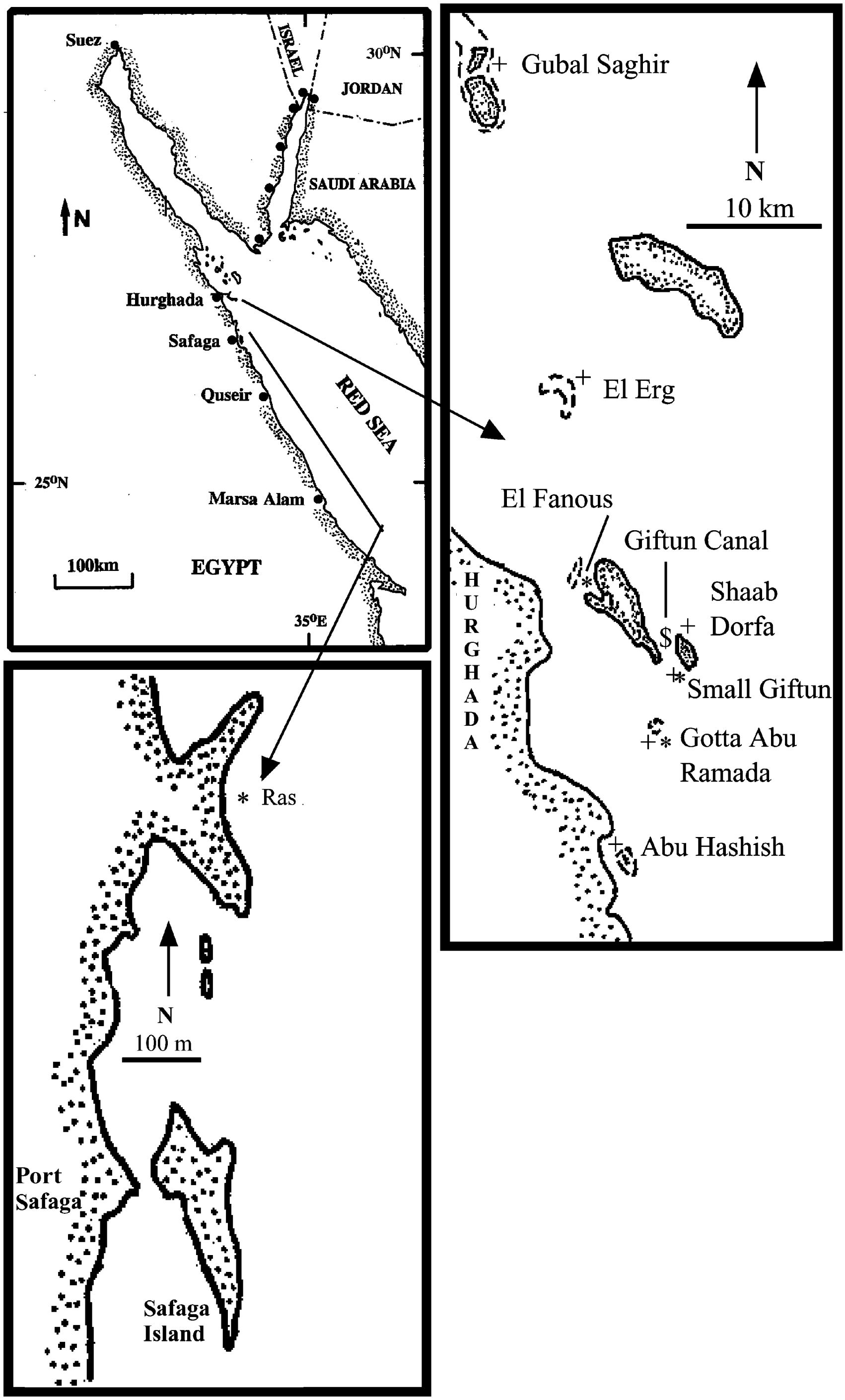

Figure 1 Location of diving sites off Hurghada and Safaga, Egypt in the Red Sea. * = 1996 transect site, $ = control site, + = 1987 Riegl and Velimirov (1991, 1994) transect site

Materials and Methods

Sites

In late 1996, three popular diving sites off Hurghada (El Fanous, Gotta Abu Ramada and Small Giftun) and one off Safaga (Ras Abu Soma) were selected for quantitative analysis in areas frequented by diving vessels and where mooring buoys were located or scheduled for installation (Figure 1). All transects were marked with stainless steel rods. Attached to each rod was a white cable tie and a yellow tag denoting 'Park Study Site'.

The control site

Giftun Canal was selected as the control site because it had minimal anchor and diving pressure and physical environmental conditions were similar to the four impacted sites.

Quantitative transects

The Global Coral Reef Monitoring Network (GCRMN) line-intercept-transect method (English *et al.*, 1997; Pernetta, 1993) was used to obtain lifeform percentage cover data (Table 1). Five 20 m long transects were run at 4 and 8 m depths for a total of 10 transects per site (Tables 2–6). A 10 m transect length was determined as adequate using a species-transect length curve. However, a 20 m transect length was actually used to be consistent with GCRMN protocols (English *et al.*, 1997). Fifty transects were run for the entire damage assessment.

Control comparison

To compare the minimally impaired control site to the four impacted diving sites, appropriate lifeform categories were combined to obtain total average per cent cover for hard coral (ACB, CB, CE, CF, CM – see Table 1), soft coral

Table 1 Global Coral Reef Monitoring Network life form categories used in the damage assessment

DC, Recently dead coral: recently dead, white to dirty white
ACB, *Acropora* branching: at least 2 degree branching
CB, Non-*Acropora* branching: at least 2 degree branching
CE, Non-*Acropora* encrusting: major portion attached to substrate as a laminar plate
CF, Non-*Acropora* foliose: coral attached at one or more points, leaf-like appearance
CM, Non-*Acropora* massive: solid boulder or mound
SC, Soft coral: fleshy soft corals, fans, octocorals
SP, Sponges: all types
OT, Other taxa: ascidians, anenomes, gorgonians, giant clams, etc.
TA, Total algae: any species
S, Sand: all types
R, Rubble: unconsolidated coral fragments
WA, Water: fissures deeper than 50 cm
RCK, Rock: reef pavement including limestone boulders, granite and volcanic rocks
BCC, Broken coral colonies: is a special lifeform category added to the survey to detect physical damage (Jameson *et al.*, 1999).

Table 2 Lifeform per cent cover quantitative data (collected in October 1996) from five transects (T) at El Fanous (4 and 8 m depths) off Hurghada, Egypt, Red Sea (27°16.06′N, 33°53.20′E)

El Fanous (4 m depth)					
LIFEFORM	T1	T2	T3	T4	T5
DC	1	0	4	9	20
ACB	3	5	33	35	65
SC	1	7	29	33	1
OT	0	1	2	0	0
TA	17	2	5	3	1
S	0	0	7	0	0
R	0	5	0	0	7
WA	0	5	0	0	0
RCK	71	80	20	20	6
BCC	0	0	0	0	4
El Fanous (8 m depth)					
LIFEFORM	T1	T2	T3	T4	T5
DC	0	1	10	15	26
ACB	1	3	18	41	52
SC	0	1	20	8	1
SP	0	0	0	0	1
TA	7	43	2	5	3
S	78	28	49	0	0
R	0	0	1	0	0
RCK	14	24	0	31	17
BCC	0	17	5	0	0

(SC) and total algae (TA). Data from the 4 and 8 m transects were combined because all transects were in the same coral reef zone, with the same physical environment.

Historical comparison

To provide a historical perspective of the condition of dive sites, quantitative monitoring data from 1987 (Riegl & Velimirov 1991, 1994) was compared to the 1996 damage assessment data for the Small Giftun site (Table 8). This comparison provides a look at conditions before extensive anchor, blast fishing (Riegl & Luke, 1998) and diver-related damage had occurred in the area versus the time when physical damage had peaked and mooring buoys were just being installed. Methods for data collection are outlined in Riegl and Velimirov (1991, 1994).

It should be noted that the comparison data was not collected along the exact same transect lines in the 1987 and 1996 studies. Therefore, precise comparisons with respect to change in per cent cover cannot be made. However, major trends can be observed and these are useful to coral reef managers. In this assessment, only data from similar (lee-side) communities were compared.

Results

Transect data

Lifeform percentage cover data for each site is listed in Tables 2–6.

Table 3 Lifeform percent cover quantitative data (collected in September 1996) from five transects (T) at Gotta Abu Ramada (4 and 8 m depths) off Hurghada, Egypt, Red Sea (27°09.26′N, 33°53.20′E)

Gotta Abu Ramada (4 m depth)					
LIFEFORM	T1	T2	T3	T4	T5
DC	15	1	6	2	0
ACB	0	14	1	0	0
CB	9	1	1	14	4
CE	3	0	2	3	2
CF	0	0	1	0	3
CM	21	2	17	11	24
SC	0	0	0	9	4
OT	1	0	0	0	0
TA	21	6	3	0	39
R	4	8	0	0	0
WA	0	7	0	0	1
RCK	26	61	69	61	23
BCC	3	0	0	0	0
Gotta Abu Ramada (8 m depth)					
LIFEFORM	T1	T2	T3	T4	T5
DC	10	10	2	7	3
CB	38	8	18	0	6
CE	2	0	2	0	1
CM	3	40	4	2	32
SC	8	1	15	12	6
OT	10	0	0	0	0
TA	3	7	0	16	6
S	13	9	0	5	7
WA	0	4	2	0	4
RCK	13	15	66	18	34
BCC	3	0	0	0	0

Control comparison

Table 7 lists the total average percentage cover for hard coral, soft coral and total algae for the diving sites in relation to the control site.

Historical comparison

A historical comparison from 1987 to 1996 of quantitative transect data for total average percentage cover of hard coral, branching *Acropora* coral, soft coral and total algae at the Small Giftun diving site off Hurghada, Egypt is provided in Table 8.

Discussion

To provide a full understanding of the condition of the diving sites surveyed and implications for sustainable tourism, we analysed the damage assessment data from three perspectives using general field observations, a control site comparison and a historical comparison. Jameson *et al.* (1999) analyses the extent and severity of the damage from a diving use/carrying capacity perspective using The Coral Damage Index.

Table 4 Lifeform per cent cover quantitative data (collected in November 1996) from five transects (T) at Ras Abu Soma (4 and 8 m depths) off Safaga, Egypt, Red Sea (26°50.29′N, 33°59.80′E)

Ras Abu Soma (4 m depth)					
LIFEFORM	T1	T2	T3	T4	T5
DC	21	27	29	13	18
ACB	25	29	28	45	39
SC	36	35	31	19	31
TA	0	1	1	9	1
S	0	0	1	0	0
R	9	0	2	2	6
WA	2	0	0	2	0
RCK	7	8	8	10	5
BCC	2	0	2	4	2
Ras Abu Soma (8 m depth)					
LIFEFORM	T1	T2	T3	T4	T5
DC	22	12	6	19	8
ACB	48	39	57	61	46
SC	24	42	31	6	27
TA	2	1	0	4	1
S	0	0	2	0	2
R	0	0	0	4	8
WA	1	0	2	0	1
RCK	3	6	2	6	7
BCC	0	0	0	4	1

General field observations

The general impression from field observations during transect operations was that all four diving sites (excluding the control site) suffered in varying degrees from physical damage and needed management attention. Some transect locations (in total or in part) had experienced severe physical damage while other transect locations had escaped damage. The data in Tables 2–6 demonstrate the large variation in lifeform per cent cover values for hard coral categories (ACB, CB, CE, CF, CM) among transects at both 4 and 8 m depths for each of the four impacted sites (less so for the minimally impaired Giftun Canal control site). The location, severity and extent of damage can be determined more accurately by using The Coral Damage Index (Jameson *et al.*, 1999).

Control comparison

The most obvious difference between the control site and the four damaged sites (at both 4 and 8 m depths) is the consistently high per cent cover of hard coral (especially *Acropora* coral) and low per cent cover of soft corals among all transects at the Giftun Canal control site. Total algae (TA) percentages are also consistently higher at impacted transect sites (Tables 2–6) versus the control site (Table 7).

Table 5 Lifeform per cent cover quantitative data (collected in September 1996) from five transects (T) at Small Giftun (4 and 8 m depths) off Hurghada, Egypt, Red Sea (27°10.15′N, 33°50.85′E)

Small Giftun (4 m depth)					
LIFEFORM	T1	T2	T3	T4	T5
DC	15	2	3	8	0
ACB	5	8	0	34	49
CB	1	0	4	0	0
CE	2	2	6	0	0
CM	6	0	14	0	0
SC	5	8	38	15	11
TA	5	0	3	2	6
R	0	0	10	0	13
WA	0	10	0	0	0
RCK	59	72	22	39	20
BCC	0	0	8	7	8
Small Giftun (8 m depth)					
LIFEFORM	T1	T2	T3	T4	T5
DC	1	3	2	0	1
ACB	15	13	0	4	40
CB	0	2	5	0	0
CE	0	1	0	0	0
CM	21	2	17	11	24
SC	16	26	54	44	34
SP	0	0	0	2	0
TA	7	6	4	5	1
R	0	0	6	0	5
WA	0	5	0	0	0
RCK	61	43	21	45	19
BCC	0	0	3	0	4

Historical comparison

The most alarming statistics from the Small Giftun 1987 to 1996 comparison (Table 8) involve the dramatic changes in per cent hard coral, soft coral and total algae cover.

- There was a 43% reduction in per cent hard coral cover over the 9-year period.
- The per cent cover of soft coral increased by 100%.
- Total algae cover increased over 400%.

In studies from other neighbouring diving sites, The Marine Conservation Society (Wood *et al.*, 1996) from their 1981 to 1996 comparison of reef conditions shows deteriorating trends in Sha'ab Fanadir and Giftun Seghir SE. In contrast, the non-commercial diving sites of Ras Fanadir (wind-exposed location with low usage), Crescent Reef (located off Hurghada Marine Science Station) and Sheraton Reef (too shallow to be a diving site, often visited by glass bottom boats) showed little signs of deterioration from the 1981 to 1996 time period reinforcing the notion that physical damage from anchors and divers, that removes coral and provides new substrate for soft coral and algal recruitment, is the major factor causing this ecosystem change and degradation of dive site quality.

Table 6 Lifeform per cent cover quantitative data (collected in October 1996) from five transects (T) at Giftun Canal (4 and 8 m depths) off Hurghada, Egypt, Red Sea (27°10.02′N, 33°50.07′E). Giftun Canal was used as the control site for the damage assessment

Giftun Canal (4 m depth)					
LIFEFORM	T1	T2	T3	T4	T5
DC	5	5	10	9	4
ACB	88	16	59	68	47
SC	0	12	4	1	2
OT	2	3	1	2	2
TA	4	4	5	6	6
S	0	13	1	5	0
R	0	2	0	0	0
WA	0	0	3	1	24
RCK	1	45	17	8	15
BCC	0	3	0	0	0
Giftun Canal (8 m depth)					
LIFEFORM	T1	T2	T3	T4	T5
DC	5	3	2	12	3
ACB	80	22	15	27	21
CM	0	0	10	0	0
SC	0	10	0	6	7
SP	1	0	0	2	2
OT	1	3	0	1	0
TA	1	1	2	2	1
S	2	36	59	29	57
R	0	0	0	2	0
RCK	10	25	12	19	9
BCC	0	0	0	3	0

Table 7 Total average per cent cover for hard coral, soft coral and total algae for five diving sites off Hurghada and Safaga (S), Egypt, Red Sea in late 1996 (average of transect data collected at 4 and 8 m depths)

Diving site	**Hard Coral (*SD*)**	**Soft Coral (*SD*)**	**Total Algae (*SD*)**
El Fanous	25.6 (22.9)	10.1 (12.6)	8.8 (12.9)
Gotta Abu Ramada	28.9 (13.5)	5.5 (5.4)	10.1 (12.2)
Ras Abu Soma (S)	41.7 (12.1)	28.2 (10.1)	2.0 (2.7)
Small Giftun	28.6 (17.2)	25.1 (16.7)	3.9 (2.3)
Giftun Canal[a]	45.3 (26.8)	4.2 (4.4)	3.2 (2.0)

[a] Control site.

Table 8 Historical comparison of quantitative transect data for total average per cent cover of hard coral, soft coral, branching *Acropora* coral and total algae at the Small Giftun diving site off Hurghada, Egypt from 1987 to 1996

Small Giftun (per cent cover)	***1987 (SD)***	***1996 (SD)***	***TREND***
Hard Coral	49.9 (5.9)	28.6 (17.2)	↓
Acropora Branching Coral	22.8 (16.2)	16.8 (17.7)	↓
Soft Coral	12.5 (3.1)	25.1 (16.7)	↑
Total Algae	0.75 (1.8)	3.9 (2.3)	↑

Comparison note: The 1987 data (Riegl & Velimirov, 1991, 1994) was collected in the same lee-side vicinity as the 1996 data (this assessment). Except for the *Acropora* data (which was an average of transect data from 4 and 8 m depths), the 1987 data was an average of transects at various depths along the reef slope. The 1996 data was an average of transect data collected at 4 m and 8 m depths.

Conclusion

All four diving sites (excluding the control site) suffered in varying degrees from physical damage and need management attention. This damage was primarily caused by anchor and diver damage (Jameson *et al.*, 1999). Some transect locations (in total or in part) had experienced severe physical damage while other transect locations had escaped damage.

Qualitative rapid ecological assessment quadrat data (1996) from over 40 other diving sites in the Hurghada and Safaga area also exhibited these negative impacts (Jameson *et al.*, 1997).

From 1987 to 1996, it is also clear that there were major negative impacts to the ecological condition of the coral reef system and to the aesthetic quality of these economically valuable diving sites.

Because of the great variation in the amount of physical damage within and among diving sites, management and restoration efforts should be conducted on a site-by-site basis.

Since 1996, EEAA has taken a more active role in managing diving activities and coral reef resources. EEAA unpublished monitoring data for 2000 and 2002 show that many impacted sites are recovering as a result of the mooring buoy programme (Dr. Mohamed M. Abou Zaid, personal communication).

While this recovery is encouraging, it is important to recognise that other factors – which are even more difficult to control – related to global climate change (i.e. increased sea surface temperature), are silently stressing the coral reef system (Buddemeier, 2001). In 2003, EEAA rangers estimated that the number of diving centres in the Hurghada area had grown to 140 (from 80 in 1996). If the tourism industry is to sustain itself in the Egyptian Red Sea, every management effort must be made to minimise the sources of stress on the coral reefs we can effectively control. This includes: not overfishing, minimising anchor, diver and blast fishing damage; not exceeding dive site carrying capacities, and eliminating stress from development activities such as impacts from sedimentation, nutrification and toxic chemicals. In this light, the following recommendations can be offered:

(1) Continue the ongoing and successful programme of installing and maintaining mooring buoys.
(2) Continually upgrade and expand the ranger enforcement/management programme.
(3) Periodically monitor all diving sites for physical damage and ecological changes and submit results to the Global Coral Reef Monitoring Network (www.gcrmn.org) and scientific journals for publication.
(4) Through the new Egyptian national environmental impact assessment process, minimise as many forms of development-related stress to the coral reef system as possible.
(5) Top priority should be given to establishing effective dive site management programmes in the Red Sea. This was an urgent requirement in 1996 and remains a key issue 10 years later. Dive site management programmes should be based on published peer-reviewed carrying capacity research. Diver education, diver proficiency and other factors should be factored into determining carrying capacities for diving sites. Considering the amount

of damage done to diving sites from 1987 to 1996, and their need for recovery, it is recommended that dive site management programmes in the Hurghada and Safaga areas be established using the carrying capacity figure of 6000 dives per year per site (Hawkins & Roberts, 1997). It is critical to have stakeholder involvement and buy-in during the development of these programmes. If valid peer-reviewed research shows this carrying capacity figure can be increased, then programmes can be easily modified.

Options

Jameson (1997) and Jameson *et al.* (1997) explored several options for the design of dive site management programmes for the Red Sea as part of the research programme outlined. They remain valid. Their advantages and disadvantages are summarised as follows:

Option 1: Limit the number of diving vessels

Only a limited number of diving vessels would be sold permits to operate in the Protectorate. Vessels sold permits would have to meet strict safety and quality standards. The number of diving vessels permitted to operate in the area would be based on carrying capacity research, the ecological condition of diving sites and the estimated amount of diving conducted per vessel.

Advantages: Simple to implement and administer, would produce a higher quality diving vessel fleet and reduce harbour congestion.

Disadvantages: Would put many existing diving vessel operators and diving centres out of business.

Option 2: Dive site stock market

Carrying capacities would be set at diving sites and diving rights (a certain number of dives per day at each site) would be sold to diving centres, by auction, in 6-month blocks. Once sold, diving rights would not be transferable and there would be no refunds. Heavily damaged sites (mainly rough weather sites) could be closed or carrying capacities significantly reduced to allow for recovery. Restoration assistance could be provided to speed recovery.

Advantages: Applicable to all areas and sites (beach and offshore). Market forces would dictate cost of diving. Government would not have to set user fee. Pressure on selected reefs would be reduced.

Disadvantages: Not all dive centres would be able to participate.

Option 3: Allocation system

A predetermined number of diving centres would be allocated certain diving sites at specified days of the week. Diving centres would pay a fixed fee for these rights. Carrying capacities would be set for each site and the number of divers limited accordingly. Less diving would be allowed on heavily damaged sites to allow for managed recovery.

Advantages: Spreads diving out equitably among diving centres, to all sites, in a sustainable manner.

Disadvantages: It would be impossible to give all of the existing Hurghada diving centres enough dives, and stay within dive site carrying capacities, to keep many diving centres profitable. The Government of Egypt would have to select participating diving centres using an appropriate method to make this system work (e.g. auction off a certain number of dive centre licenses, pick names out of the hat, etc.).

Option 4: First come – first served

The number of mooring buoys would be limited at each site based on carrying capacity decisions. All vessels must use mooring buoys during diving operations. Only a certain number of vessels would be allowed to raft on one mooring buoy. Buoys are allocated on a first come – first served basis (no place holding allowed). Drift diving could be regulated at sites if deemed necessary. A user fee would be charged to all vessels operating in the Protectorate. New sites would be marketed to spread out use.

Advantages: Easy to administer. Spreads diving out among selected sites.

Disadvantages: More expensive for diving centres as it will require diving vessels to search for open buoys at other sites.

Option 5: First come – first served with zones

Like option 4 but four zones would be established within various management centres (Hurghada, Safaga, etc.).
Zone 1: Inshore and local core area that is within easy reach from the main centres by any local vessel
Zone 2: Day trip area that could be reached only after several hours of travel and needs a whole day for the complete trip.
Zone 3: First safari zone that could only be reached by safari boats and they will generally spend several days and overnight in this zone.
Zone 4: Second safari zone that could only be reached by specially equipped safari boats. These are the most remote areas in terms of accessibility to central populated areas, and the most costly to patrol.
The zones would be colour-coded and boats need to display a sticker to indicate their license, and zone permitted to operate in. The purchase of a license for zone 4 automatically includes the right to operate in zones 1–4. A license for zone 3 allows the right to operate in zones 1–3, etc.

The zones would always apply to the restrictive management centres only, i.e. Hurghada area only, or Safaga area only and so on. A boat moving from one management centre to an adjacent centre would require a zone 3 permit. A boat moving through or operating in several management centres would need a zone 4 permit. The permits would only be issued at the home centre.

A centre could only operate with an established ranger presence.

Advantages: Spreads diving out among selected sites. Zones allow more control over which vessels operate where.

Disadvantages: More expensive for diving centres as it will require diving vessels to search for open buoys at other sites. Also, it is more difficult to administer.

Option 6: Status quo with continual restoration

Install more mooring buoys to accommodate the demand at diving sites. Use user fees to pay for continual coral reef restoration at damaged sites. Market new sites to spread out use.

Advantages: Does not disrupt status quo.

Disadvantages: Restoration expensive.

Option 7: Limited volume control with continual restoration

This option is similar to Option 6 but in this case liberal carrying capacities are set for diving sites thus only slightly limiting the status quo situation. User fees would pay for continual coral reef restoration at damaged sites. New sites would be marketed to spread out use.

Advantages: Minimal status quo disruption.

Disadvantages: Restoration expensive.

Option 8: Sacrificial sites with adjacent artificial reefs

Allows present high volume diving to occur for a standard user fee, without any volume controls, at selected already damaged dive sites. Near these sacrificial areas, new artificial reefs would be created. Over time, diving could shift to the artificial reefs and then the sacrificial reefs could be closed for restoration. Dives at non-sacrificial areas would cost more and diving volume would be maintained at sustainable levels via predetermined carrying capacities. Selected windy day dive sites would have limited access and cost more to use – thus preserving the quality of some windy day sites. New sites would be marketed to spread out use.

Advantages: Minimises disruption of present dive vessel routine. Reduced economic impact to diving industry.

Disadvantages: Artificial reefs would be expensive to construct. Some lee-side diving sites would eventually become so damaged they would have to be closed – leaving fewer expensive windy day sites.

Option 9: Multi-option plan

This option would allow one to use various combinations of the earlier-mentioned options as appropriate. For example, Options 1 and 2 might be used in the Hurghada area and Option 3 in the less-developed areas to the south of Hurghada.

Advantages: Maximum flexibility.

Disadvantages: Could be confusing to understand and more difficult to administer. Could have greater economic impacts on existing dive operators.

Option 10: Phased approach

This option would use one or a combination options during the first few years, then another option or combination of options during later years.

Advantages: Maximum flexibility.

Disadvantages: Could be confusing to understand and more difficult to administer.

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Note

1. The Elba Protectorate covers 10,000 sq. km from south of Ras Banas to the Sudan border and out to the 100 m isobath. It includes islands and significant mangrove areas.

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